Int J Life Cycle Assess (2010) 15:726–736
DOI 10.1007/s11367-010-0197-y

DISCUSSION ARTICLE

Environmental benefits from reusing clothes

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Received: 11 March 2009 / Accepted: 29 April 2010 / Published online: 27 May 2010

Abstract
Background, aim, and scope Clothes are often discarded when much of their potential lifetime is left. Many charitable organizations therefore collect used clothing and resell it as second-hand clothes for example in Eastern Europe or Africa. In this connection, the question arises whether reusing clothes actually results in a decrease of the environmental burden of the life cycle of clothing. The environmental burden of clothing has been studied in several studies. However, most of these studies focus solely on the energy consumption aspects and pay little attention to the potential benefits of diverting used clothing from the waste stream. The aim of the study was to assess the net environmental benefits brought by the disposal of used clothing through charities who return them for second-hand sales assuming that second-hand clothes to some extent replace the purchase of new clothes.
Materials and methods The extent to which second-hand clothes (SHC) introduces such a replacement was investigated applying a methodology in which a questionnaire-based survey was conducted on more than 200 consumers in second-hand shops. The survey was done in Sweden and Estonia, and Africa was included by estimation. Based on the identification of the different profiles of the consumers questioned, a methodology was developed to get a quantitative evaluation of the replacement of new clothes enabled by second-hand clothing consumption. A life cycle assessment was conducted based on the EDIP methodology. The life cycle impacts of clothes that are directly disposed of by incineration were compared with the life cycle impacts of clothes that are collected and sorted after consumer use in order to be reused. Two products were assessed: a cotton T-shirt and a pair of polyester (65%)/cotton (35%) trousers. The functional unit was 100 garments in the use stage.
Results Based on the survey result and the methodology applied, the purchase of 100 second-hand garments would save between 60 and 85 new garments dependent of the place of reuse. Based on information about the second-hand clothing activities conducted by Humana People to People in Sweden and Estonia, it was assumed that over 100 collected items 60 would be reused, 30 recycled in other ways, and ten go to final disposal. Using these inputs, the LCA showed that the collection, processing, and transport of second-hand clothing has insignificant impacts on the environment in comparison to the savings that are achieved by replacing virgin clothing. The reduction of impacts resulting from collecting 100 garments for reuse range from 14% decrease of global warming for the cotton T-shirt to 45% reduction of human toxicity for the polyester/cotton trousers.
Discussion The approach applied is a fair way of establishing the net benefits from introducing clothes reuse. Indeed, it enables to take into consideration all the activities connected to reusing clothes, including, for instance, recycling and disposal of the collected clothes not suitable for reuse. In addition, the routes followed by the collected clothes have been determined based on real figures. A main assumption concerns the estimation of avoided production of new clothes brought by clothes reuse. The method used, based on questionnaires, could be further developed but still suggests an approach on an issue that had not been investigated so far.
Conclusions The results of the study show that clothes reuse can significantly contribute to reducing the environmental burden of clothing.

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Recommendations and perspectives It would be beneficial to apply other methods for estimating the avoided production of new clothes in order to check the validity and reliability of the results obtained in the current study. Such further work could include the possible difference in the lifetime of second-hand clothes compared to new clothes.

Keywords Clothes reuse · Clothing · Environmental design of industrial products (EDIP) methodology · Environmental benefits · Reusing clothes · Second-hand clothes (SHC) · Second-hand shops

1 Background, aim, and scope

Clothes are often discarded when much of their potential lifetime is left. Many charitable organizations therefore collect used clothing and resell it as second-hand clothes (SHC) for example in Africa. The main purpose of the SHC trade is thus to provide cheap clothes to developing countries and to raise funds to invest in development projects. The principle is that people bring the clothes they do not want to wear anymore to 'drop-off' containers belonging to charitable organizations. It is also quite common to bring the items to local charity shops. This way, clothes can be collected separately and diverted from the waste stream. After sorting, a large proportion of these donations is then sold (Hansen 2004). The money from selling these clothes on the second-hand market provides funds for financing development projects. Usually, best quality items are sold in second-hand shops in the country of collection, i.e., Western Europe and North America. Low quality and torn or stained clothes are sold to the textile recycling industry while the collected clothes that cannot be used again or that are not worth recycling end up incinerated or landfilled (Fenger 2007). Among the garments usable as second-hand clothes, an important fraction is bound for Eastern Europe (e.g., winter clothes). However, the largest part of clothes is sold baled to large-scale importers in the South, mainly in Sub-Saharan Africa which is the world's largest SHC destination (Fields 2004; Hansen 2004). These importers then sell the bales to wholesalers who in turn sell the bales to other wholesalers or directly to small retailers selling the clothes on informal local markets.

The trade in SHC worldwide is currently worth around $1 billion per year while the total global trade in textiles and clothing is about $200 billion per year (Baden and Barber 2005). SHC therefore represents less than 0.5% of the total textile trade (Baden and Barber 2005). However, as second-hand clothes are usually sold at 10-20% of the price of new clothes (Fields 2004), it could be fairer to compare the volumes involved. SHC then represents about 5% of the total global trade (Baden and Barber 2005). It is also essential to note that the role played by SHC varies considerably from one country to another. For instance in Sub-Saharan Africa, SHC represents more than 25% of the value of all clothing imports (Baden and Barber 2005). In addition, according to the study realized by Karen Hansen in 1995, one third of all Sub-Saharan African people wear second-hand clothes and this proportion is likely to be even higher today due to the growth in SHC trade since the 1990s (Baden and Barber 2005).

Environmental concern has thus never been the primary motivation for reusing clothes. However, in a report edited by the European Commission clothing is reported to account for between 2% and 10% of consumers' environmental impacts (EIPRO 2006). Clothing and footwear comes after food and drink, transport, and housing that together are responsible for 70-80% of the environmental impact of consumption (EIPRO 2006). Thus, although not the largest contributor, clothing qualifies as an area of concern regarding environmental impacts and the question arises whether reusing clothes actually results in a decrease of the environmental burden of the life cycle of clothing. If it does, it would provide an additional argument to charities to encourage people to sort their clothes and to buy second-hand clothes.

The environmental burden of clothing has been studied in several studies, mainly Allwood et al. 2006; EDIPTEX 2007; and Oakdene Hollins Ltd et al. 2006. However, most of these studies focus solely on the energy consumption aspects and pay little attention to the potential benefits of diverting used clothing from the waste stream. The aim of this study was to compare the environmental impacts of the normal disposal of used clothes with the environmental impacts of reusing clothes through the collection of used clothing for second-hand sales assuming that SHC to some extent replace the purchase of new clothes. Indeed, following this assumption, second-hand clothes consumption to some extent avoids the manufacturing of clothes from virgin material. However, the SHC trade also generates some impacts from clothes collection, sorting, baling, and transportation. Additionally, the normal disposal of clothes may also involve recycling of the textile or energy generation from incineration. Thus, the net environmental benefits of reusing clothes result from the overall balance between impacts and benefits. The full study is reported in Farrant (2008).

2 Methodology

2.1 Replacement of new clothing by second-hand clothes

The first key issue addressed in the study was the estimation of the extent to which SHC replaces the

purchase of new clothes. It must be taken into consideration that second-hand clothes differ from new clothes (price, style, previous ownership…) and are considered differently by consumers. As a consequence, it cannot be assumed that each purchase of a second-hand item replaces the purchase of a new item. The extent to which SHC introduces such a replacement was investigated using a questionnaire-based survey was conducted on more than 200 consumers in second-hand shops with the collaboration of the charity organization "Humana People to People". The survey took place in Denmark, Sweden, and Estonia and the aim was to identify the different consumers profiles based on their purchase behavior and attitude towards SHC.

Inspiration was sought in "Practice theory" to structure and understand the information collected during the interviews and via the questionnaires. Practice theory is one of the numerous ways of conceptualizing social theory and enters in the "cultural theories" category (Reckwitz 2002). Practice theory pays attention to the routine and ordinary aspects of everyday practices and was used in the present study to get a better understanding of the practice of second-hand consumption. According practice theory, practices are a nexus of activities organized by association of interconnected understandings, rules, meanings, and things (Schatzki 2002; Gram-Hanssen 2008). These four components were therefore used to understand the particular second-hand consumption practice of each of the identified types of consumers (e.g., second-hand clothes lovers or consumers looking for original additional things). The idea behind this analysis was to determine how consuming second-hand clothes can be adopted as a routine and how new consumer could be brought into this practice.

A methodology was then developed to attain a quantitative evaluation of the replacement of new clothes enabled by second-hand clothing consumption. The concept of a "replacement rate" was introduced. As an illustration, a replacement rate of 50% means that the purchase of two second-hand items replaces the purchase of one new item. Following this approach, each respondent was allocated a replacement rate in the range 100-67-50-33-0%. In short, a high replacement rate was allocated to respondents looking for clothes they need in second-hand shops and wearing mostly SHC or with an intention of buying a similar item new when buying a second-hand item. On the contrary, a low replacement rate was allocated to respondents not used to wearing SHC, looking for unnecessary additional things in second-hand shops and with no intention of buying a similar item new. The new clothes replacement rate is an essential assumption for the study and Table 1 presents in details the criteria applied to estimate it.

2.2 The life cycle: system and data

The life cycle impacts of clothes that are directly disposed of by incineration were compared with the life cycle impacts of clothes that are collected and sorted after consumer use in order to be reused. The Life Cycle Assessment (LCA) followed the environmental design of industrial products (EDIP) methodology (Wenzel et al. 1997). Two basic products likely to be collected by charities were assessed: a 100% cotton T-shirt and a pair of polyester (65%)/cotton (35%) trousers. This choice allowed to compare a product based on natural fibers (cotton) with a product made from a mix between natural and synthetic fibers (polyester). The characteristics of the two products are presented in Table 2. The functional unit was 100 garments in the use stage which is taking place in Sweden.

The LCA included the whole lifecycle of the two products, from raw materials extraction to disposal or reuse as illustrated in Fig. 1. The foreground data was to a large extent literature based and sourced primarily from the EDIPTEX report (2007) published by the Danish Ministry of the Environment as well as from other existing LCA studies on clothing and textile products, mainly the study on cotton briefs and polyester trousers for Marks and Spencer (ERM 2002b) and the study on clothes reuse for the Salvation Army (ERM 2002a). Specific data were collected from Humana Sweden and Estonia providing information concerning their SHC activities and the destination of the collected clothes as displayed on Fig. 2. Following the information obtained, the clothes were assumed to be collected in drop-off containers in Sweden and then transported to Estonia for sorting. Background data was taken from the EDIP database as implemented in GaBi.

Table 3 presents the system boundaries that have been considered in the LCA and Fig. 1 gives a graphical overview of these system boundaries. The choice of excluding the zipper, buttons, and carrier bag is justified by the streamlined LCA study on cotton briefs and polyester trousers for Marks and Spencer (ERM 2002b) that shows that their contribution to the global extracted energy consumption is very limited. The zipper and buttons may have some impacts on metal resources but it has been considered acceptable to neglect them. Care labels have been excluded from the study due to their negligible weight. Regarding consumer transport, it is assumed that the trips are not dedicated to visiting the shop or to bringing the clothes to the drop-off container; therefore, no transport burden has been considered. In case the clothes are collected for reuse, system expansion is performed to include the avoided production of new clothes in the system boundaries. In addition, according to the informa-

Table 1 Replacement of new clothes enabled by second-hand clothes consumption

New clothes replacement rate	Case	Criteria	% of respondents concerned			
			Sweden/ Denmark	Estonia	Sweden/ Denmark	Estonia
100%	Case a	Less than 50% of the wardrobe coming from second-hand shops Would definitely have bought a similar item new if you had not found it in a second-hand shop (answer "*yes* " to Q.15) Second-hand shops as "a way to find the clothes you need at a cheaper price" or as "a place where you can have a chance to find clothes that you like and that fit you" (and not as "a place to find additional things")	6.7%	12.9%	26.9%	46.2%
	Case b	More than 50% of the wardrobe coming from second-hand shops Second-hand shops as "a way to find the clothes you need at a cheaper price" or as "a place where you can have a chance to find clothes that you like and that fit you" (and not as "a place to find additional things")	20.2%	33.3%		
67%		Less than 50% of the wardrobe coming from second-hand shops Would perhaps have bought a similar item new if you had not found it in a second-hand shop (answer *"maybe"* to Q.15) Second-hand shops as "a way to find the clothes you need at a cheaper price" or as "a place where you can have a chance to find clothes that you like and that fit you" (and not as "a place to find additional things")			25.0%	24.2%
50%	Case a	Less than 50% of the wardrobe coming from second-hand shops Would perhaps have bought a similar item new if you hadn't found it in a second-hand shop (answer *"maybe"* to Q.15) Second-hand shops as "a place where you can find additional things you would not have bought otherwise" and at least one of the other two possible answers	6.7%	1.5%	20.2%	12.9%
	Case b	Less than 50% of the wardrobe coming from second-hand shops Would definitely have bought a similar item new if you had not found it in a second-hand shop (answer "*yes* " to Q.15) Second-hand shops as "a place where you can find additional things you would not have bought otherwise"	4.8%	3.0%		
	Case c	More than 50% of the wardrobe coming from second-hand shops Second-hand shops as "a place where you can find additional things you would not have bought otherwise"	8.7%	8.4%		
33%	Case a	Less than 50% of the wardrobe coming from second-hand shops Would perhaps have bought a similar item new if you had not found it in a second-hand shop (answer *"maybe"* to Q.15) Second-hand shops as "a place where you can find additional things you would not have bought otherwise" and none of the other two possible answers	6.7%	0.8%	15.4%	12.2%
	Case b	Less than 50% of the wardrobe coming from second-hand shops Would not have bought a similar item new if you had not found it in a second-hand shop (answer "no" to Q.15) Second-hand shops as "a way to find the clothes you need at a cheaper price" or as "a place where you can have a chance to find clothes that you like and that fit you" (and not as "a place to find additional things")	8.7%	11.4%		

Table 1 (continued)

New clothes replacement rate	Case	Criteria	% of respondents concerned			
			Sweden/ Denmark	Estonia	Sweden/ Denmark	Estonia
0%		Less than 50% of the wardrobe coming from second-hand shops Would not have bought a similar item new if you had not found it in a second-hand shop (answer "no" to Q.15) Second-hand shops as "a place where you can find additional things you would not have bought otherwise"			6.7%	3.0%

tion provided by Humana People to People, about 40% of the collected clothes are not suitable for reuse and are discarded (Piibeleht 2008). For some of these clothes, there is a recycling potential which is the case for cotton T-shirts that are converted into wipers (Piibeleht 2008). The additional service provided by this activity needs to be taken into account. As suggested by ERM (2002a), it was assumed that the cloth wipers for industrial use would otherwise be obtained from paper wipers. Therefore, the avoided production of paper wipers was included in the reuse scenarios to make them comparable with the reference scenarios (i.e., with direct disposal). Due to lack of other relevant information, it was assumed that 1 ton of cloth wipers is equivalent to 1 ton of paper wipers (ERM 2002a). The impacts from production of cloth wipers (i.e., cleaning and shredding operations) are assumed to be negligible compared to those from production of paper wipers. For the trousers in mixed polyester and cotton, no recycling was taken into consideration since at present no recycling is taking place on a large scale for textile blends (Hansen 2008). Among key assumptions, it was also considered that second-hand garments are worn as long as new clothes.

A number of scenarios were studied:

Scenario group A: cotton T-shirts

A0. Reference scenario—with direct disposal after consumer use
A1a. Reuse scenario—with reuse in second-hand shops in Estonia
A1b. Reuse scenario—with reuse in second-hand shops in Sweden
A2. Recycling scenario—with recycling as wipers

Scenario group B: polyester/cotton trousers

B0. Reference scenario—with direct disposal after consumer use
B1a. Reuse scenario—with reuse in second-hand shops in Estonia
B1b. Reuse scenario—with reuse in second-hand shops in Sweden

3 Results

The questionnaire-based survey led to a total of 236 answers:

- 31 in Copenhagen where the questionnaire was first tested
- 73 in Sweden: 33 in Stockholm, 25 in Malmö, and 15 in Lund
- 132 in Estonia: 86 in Tallinn, 22 in Tartu, 20 in Pärnu, and four in Maardu

The rate of answers per shop ranged between four and 33 questionnaires. To make the statistics more relevant, the 31 questionnaires obtained in Copenhagen are combined with those from Sweden (cf. Table 1). It is indeed assumed that the profiles of the Danish and Swedish consumers are

Table 2 Products characteristics

	Cotton T-shirt	Polyester/cotton trousers
Composition	100% cotton (non-organic)	65% polyester/35% cotton (non-organic)
Weight	250 g (middle quality)	400 g (excluding zipper and buttons)
Conditions of use	Washed at 40°C	Washed at 40°C
	Tumble dried	Not tumble dried
	Each T-shirt ironed for 1 min	Each pair of trousers ironed for 2 min
Lifetime	50 washes	50 washes

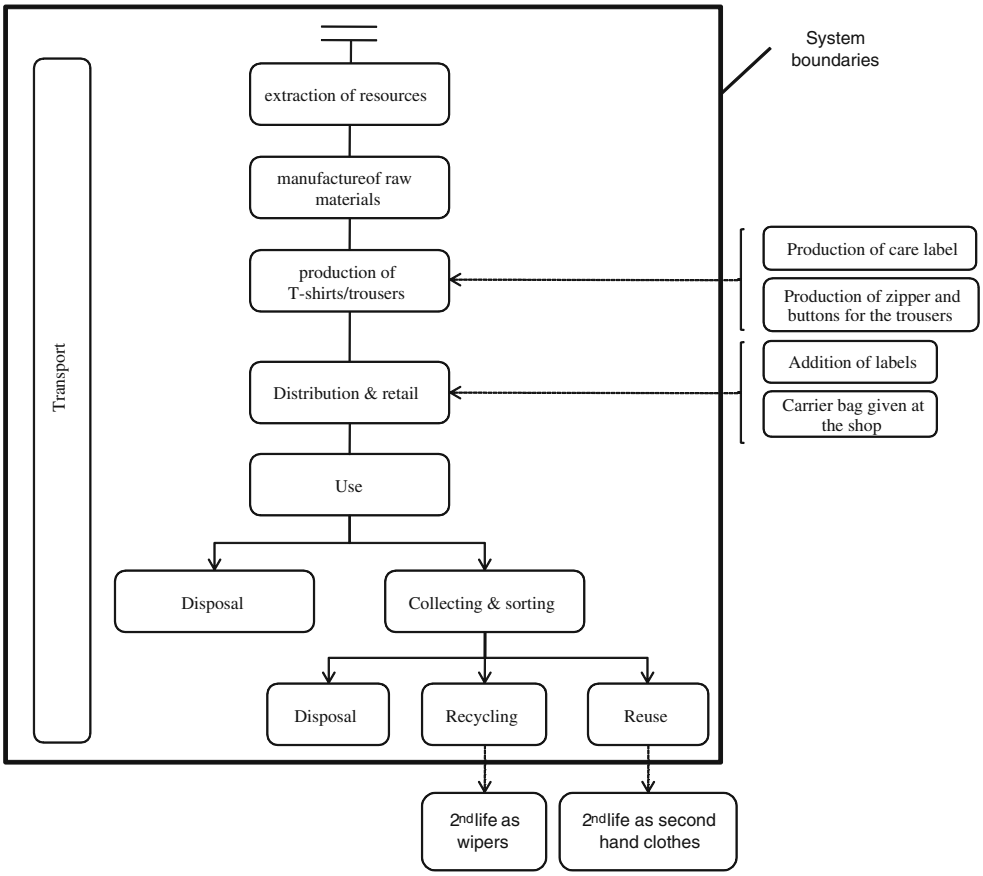

Fig. 1 Graphical overview of system boundaries

similar regarding SHC. Based on the survey result and the methodology applied, the purchase of 100 second-hand garments would save 60 new garments if the reuse takes place in Sweden and 75 new garments if the reuse takes place in Estonia (cf. Table 1). In addition, as shown on Fig. 2, about 30% of the collected clothes are destined for the African second-hand market. No field study was conducted to estimate the new clothes replacement rate for Africa but existing studies (Baden and Barber 2005; Hansen 2004) show that second-hand clothing satisfies an important part of the clothing needs of the population in Sub-Saharan Africa. It suggests that the replacement rate should be high. As a result, a replacement rate of 85% was chosen for Africa in the study.

Based on information about the second-hand clothing activities conducted by Humana People to People in Sweden and Estonia (cf. Fig. 2), it was assumed that over 100 collected items 60 would be reused. More precisely, 20 are sent back to Humana second-hand shops in Estonia (scenario A1a) or in Sweden (scenario A1b), ten are going to Lithuania (third-category clothes) and 30 are going to Africa. For T-shirts, 30 of the remaining non-reusable 40 items are recycled in wipers

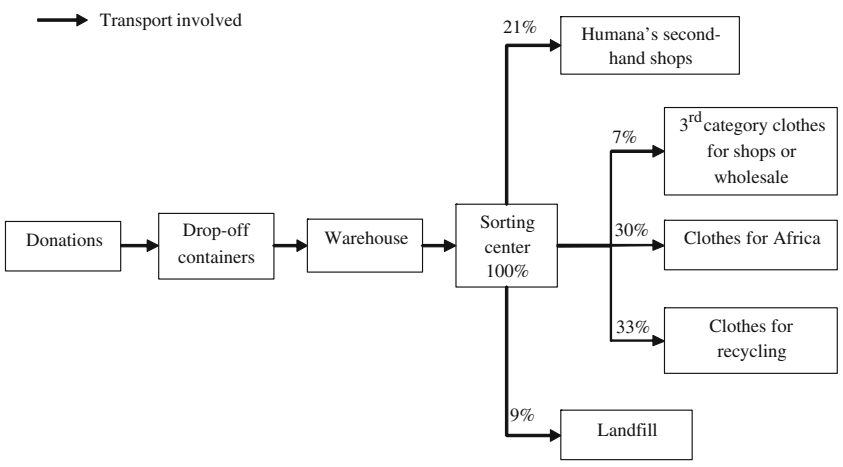

Fig. 2 Clothes collection and sorting activities at Humana Sweden and Estonia (Year 2007) (Pille Piibeleht, personal communication 2008)

Table 3 System boundaries

Within system boundaries	■ Extraction of resources ■ Manufacture of materials, including fuels and chemicals consumed ■ Electricity generation ■ Packaging for transportation ■ Distribution and retail activities ■ Consumer clothes care (washing, drying, ironing) ■ Used clothes collection, processing and distribution ■ Disposal of wastes during the "first" product life cycle ■ Transport (except consumer transport)
Outside system boundaries	■ Zipper and buttons for the trousers ■ Product care label and other labels ■ Carrier bag given when the item is purchased ■ Consumer transport ■ Capital equipment ■ Maintenance of buildings and equipment ■ Energy consumption in the second-hand shops ■ All post re-sale life cycle stages after delivery to the second-hand user (e.g. washing during the second use phase, disposal after the second use)

and ten go to final disposal in landfills. All 40 non-reusable trousers are assumed to be landfilled. Clothes for disposal are assumed to be landfilled and not incinerated since incineration is not yet widespread in Estonia.

The reference scenarios (scenario A0 and B0) estimate the impacts generated and resources consumed over the whole life cycle for the two products in the case the garments were directly incinerated after consumer use. It appears that global warming and acidification are the main impacts for both products. However, cotton T-shirts have a stronger impact than polyester/cotton trousers on global warming, nutrient enrichment, and ozone depletion. The contribution of each stage of the products life cycle to the various environmental impacts was also studied, see Fig. 3. It revealed that the highest contribution to global warming for the T-shirts is due to the use stage since 65% of the total impacts on global warming result from the use stage. Indeed, the T-shirts are assumed to be tumble dried while the trousers are not. The emissions of CO_2 associated with the energy use for tumble drying are responsible for the T-shirts' additional contribution to global warming. During the raw material stage, the polyester/cotton trousers cause

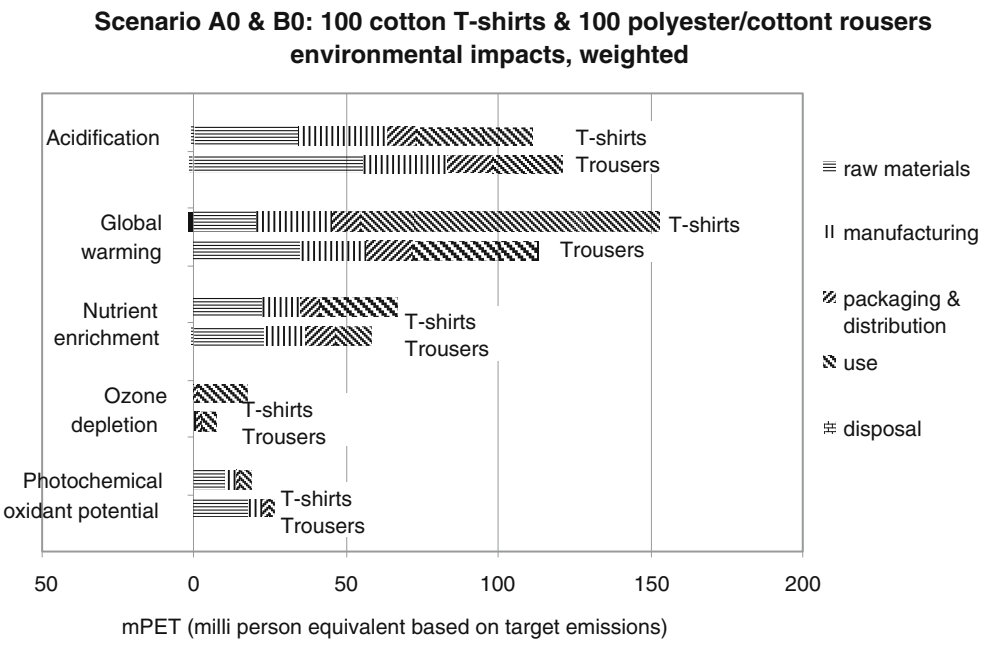

Fig. 3 Aggregated environmental impacts by life cycle stages

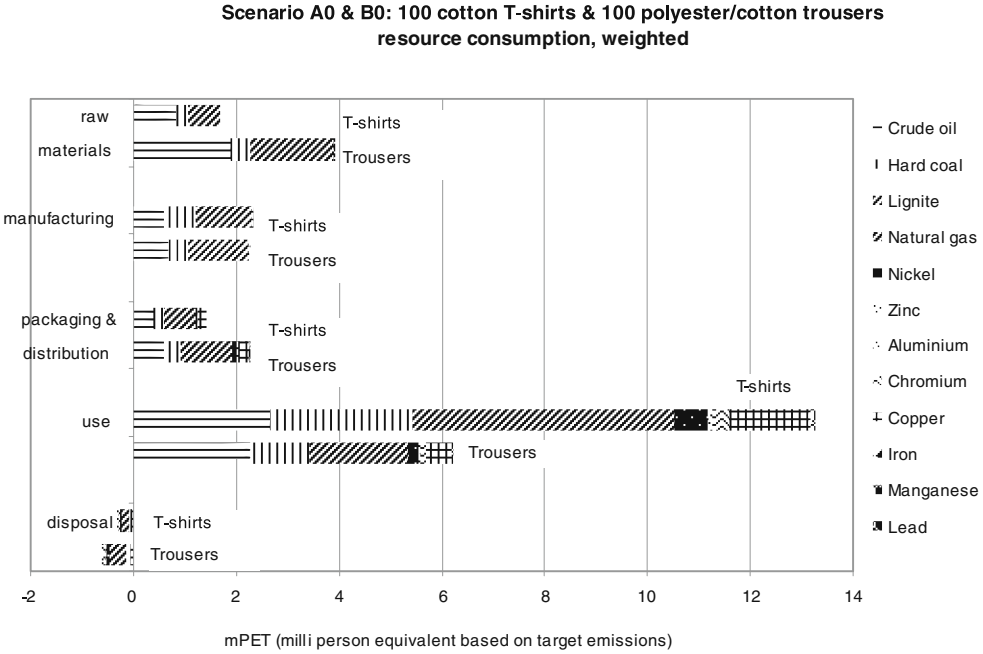

Fig. 4 Resource consumption by life cycle stages

more environmental impacts than the T-shirts, especially regarding acidification. Indeed, for the trousers, the impacts of the raw material phase dominate because of the polyester fiber production process. Regarding resource consumption, the use phase dominates for both products but the overall resource consumption is about 30% higher for the cotton T-shirts, see Fig. 4. The main resources consumed are by far the energy related ones, i.e., crude oil, hard coal, lignite (brown coal), and natural gas. Toxicity impacts for the references are shown in Fig. 5.

In comparison to this reference, the savings brought by the introduction of clothes reuse are then calculated see Figs. 6 and 7. Using the inputs/assumptions mentioned above, the LCA showed that the collection, processing, and transport of second-hand clothing has insignificant impacts on the environment in comparison to the savings that are achieved by replacing virgin clothing. In the reuse stage, benefits exceed the overall impacts by about 25 times for the T-shirts and by about 20 times for the trousers. This general overall result shows that the reuse stage is environmentally beneficial and that clothes reuse introduces a potential for reducing the environmental impacts generated over the overall life cycle of clothing.

When 100 T-shirts enter the used clothes business (scenario A1a), the environmental burden of the life cycle is decreased by 14% for global warming compared to the case where the items are directly discarded (scenario A0). For acidification and nutrient enrichment, the impacts are reduced by about 28% and 25%, respectively. Concerning resource consumption, natural gas, and crude oil consumptions are both decreased by about

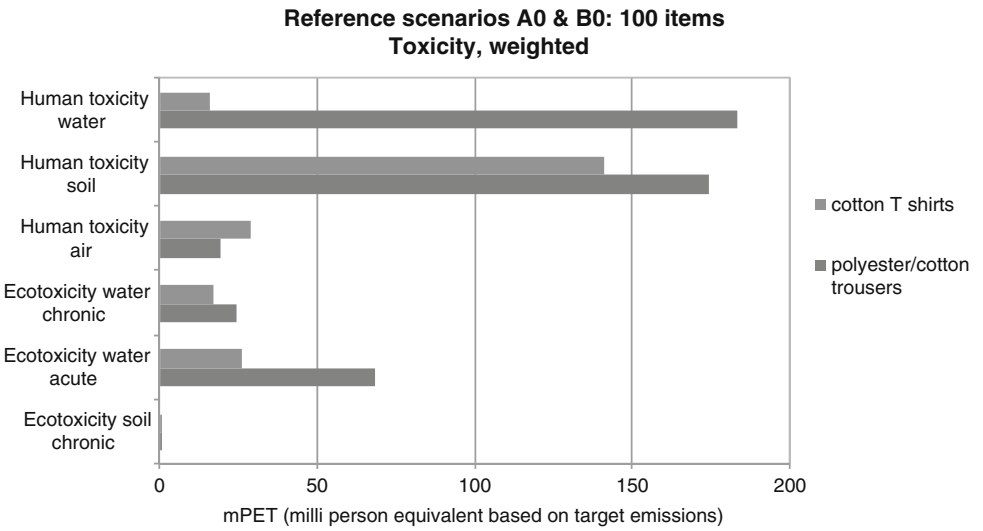

Fig. 5 Total toxicity impacts of T-shirts and trousers

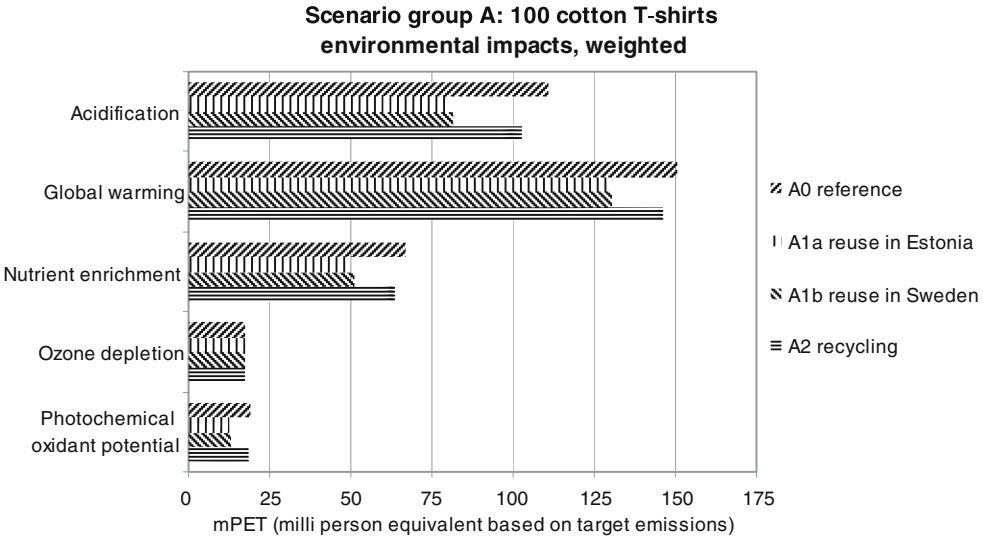

Fig. 6 Environmental impacts of different scenarios—T-shirt

15%. In addition, a 30% reduction of waste and a 24% saving for human toxicity in soil have been estimated. However, it should be mentioned that due to lack of knowledge on some substances, the uncertainty related to the evaluation of toxicity is much higher than for other environmental impact categories (Hauschild 2007). For 100 polyester/cotton trousers (scenario B1a), the contribution to global warming is reduced by 23%, which exceeds the reduction observed for the T-shirts. Impact reductions for acidification and nutrient enrichment are similar to the ones observed for the T-shirts. Natural gas and crude oil consumptions are both decreased by about 20%. Regarding toxicity, the reduction of the human toxicity in water reaches about 45% while the human toxicity in soil is decreased by 30%. Waste is reduced by about 25%. The savings associated with reusing polyester/cotton trousers are on average higher than for T-shirts since the impacts during the raw material and manufacturing stages are more important.

The results also revealed that when the clothes bound for second-hand shops (20% of the collected clothes) are sold in Sweden rather than in Estonia, the avoided environmental impacts are slightly smaller. This is explained by the smaller replacement rate of new clothes assumed for Sweden. It was also observed that the recycling scenario A2 does not bring as much benefit as the reuse scenarios A1a and A1b. Indeed, T-shirts recycling brings less than 8% reduction in impacts in all categories.

4 Discussion

The benefits have been calculated by comparing the impacts of the life cycle of 100 garments that are directly disposed of by incineration after consumer use with those of the life cycle of 100 garments that are collected and sorted after consumer use to be reused when possible. The

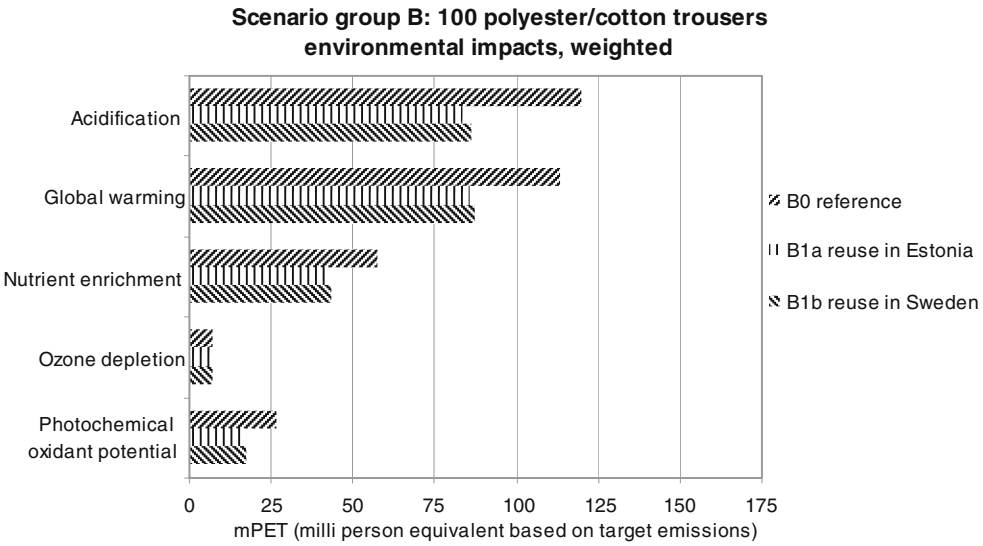

Fig. 7 Environmental impact of different scenarios—trousers

approach applied is a fair way of establishing the net benefits from introducing clothes reuse. Indeed, it enables to take into consideration all the activities connected to reusing clothes, including for instance recycling and disposal of the collected clothes not suitable for reuse. In addition, the routes followed by the collected clothes have been determined based on real figures provided by a charitable organization involved in the second-hand clothing trade. A main assumption concerns the estimation of avoided production of new clothes brought by clothes reuse. The complexity of this question is addressed in previous studies without bringing any suggestion on how to tackle it. This study therefore suggested a first approach based on a consumer survey to address this key issue. The questionnaire survey and the qualitative interviews proved useful on an issue that had not been investigated so far. However, the method can be further developed. An issue that could be further investigated is the possible difference in the lifetime of new clothes and second-hand clothes. The evaluations of this study have been made assuming that second-hand clothes can be worn as long as an item bought new. This assumption seemed acceptable since second-hand items are generally in good condition. However, in case the piece of clothing has already been worn a lot before being into the second user's hands, the period of time the second user will be able to wear it might be shorter than if the item had been new. This would affect the new clothes replacement rate. The assumption can therefore have high importance in assessing the environmental benefits from reusing clothes.

It should also be underlined that the study was conducted based on the specific case of Humana People to People's activities in Sweden and Estonia. Another charity would probably have a different way of operating, which would influence the data background of the assessment. For example, the Red Cross in Denmark only resells second-hand clothes in Denmark and does not export any clothes.

5 Conclusions

The aim of this study was to assess the environmental benefits from reusing clothes. It can be assumed that SHC to some extent replaces new clothes and thus an important (and tricky) task was to estimate the quantity of clothes made from virgin material that are avoided by the introduction of clothes reuse.

The methodology applied consisted in conducting a questionnaire-based survey on consumers in second-hand shops belonging to charitable organizations. The survey enabled to identify the different types of attitude and behavior towards SHC. According to the given answers, each respondent was allocated a replacement rate estimating the degree up to which the purchase of a second-hand item replaces the purchase of a new item.

Based on the results of the survey among more than 200 SHC consumers, it was estimated that the purchase of 100 second-hand garments would save between 60 and 85 new garments dependent of the place of reuse. The LCA showed that the collection, processing, and transport of second-hand clothing have insignificant impacts on the environment in comparison to the savings that are achieved by replacing virgin clothing. The reduction of impacts resulting from the collection of 100 used garments ranges from 14% decrease of global warming for the cotton T-shirt to 45% reduction of human toxicity for the polyester/cotton trousers. The results of the study thus show that clothes reuse can significantly contribute to reducing the environmental burden of clothing.

6 Recommendations and perspectives

It would be beneficial to apply other methods for estimating the avoided production of new clothes in order to check the validity and reliability of the results obtained in the current study. Such a further work could include the possible difference in the lifetime of second-hand clothes compared to new clothes.

The study has revealed that clothes reuse can significantly help to reduce the environmental burden of clothing. It is therefore interesting to discuss which initiatives charities could undertake to optimize these environmental benefits. It has been shown that the collection, processing, and transport of second-hand clothing has insignificant impacts on the environment in comparison to the savings that are achieved by reducing the quantity of virgin clothing that is needed. As a result, initiatives such as reduction of transport distances would have a limited effect on increasing the environmental benefits. Instead, priority should be given to strategies aiming at maximizing the credit resulting from the reduced need for the manufacturing of new clothes. This amounts to increasing the replacement rate and thus to teaching consumers to consider second-hand shops as another way of finding the clothes they need. Consumer attitudes towards reuse therefore need to develop and charities have an important role to play in educating consumers. Before bringing up the environmental aspects, charities should ensure that consumers are convinced that they can find nice items second hand. The potential for attracting new consumers depends on the offer of second-hand shops. The clothes themselves, through for example shape, design, color, will still stay the main reason for buying for consumers, together with the price advantage. That is why it is important to act on the donors' side to

ensure good quality items and large choice. Also, trends of bringing second-hand shopping to Main Street, e.g., of high-end branded clothes need to be studied. Nevertheless, SHC will always be last year's fashion and thus less attractive. This may be the point where the environmentally friendly argument can be the counterweight. In the recent years, some encouraging trends have indicated a change in consumer shopping behavior, like the increasing success of fair trade and organic products. These are signs that consumers want to take more responsibility for their shopping (Nakano 2006). Raising awareness on the impacts of clothes over their lifecycle and promoting the benefits from reuse is therefore important. This study provided tangible proof that reusing clothes saves a significant amount of environmental impacts and resources and could thus be used by charities to promote clothes reuse.

References

Allwood J, Laursen SE, Malvido de Rodriguez C, Bocken N (2006). Well dressed? The present and future sustainability of clothing and textiles in the United Kingdom. University of Cambridge Institute for Manufacturing. Available at http://www.ifm.eng.cam.ac.uk/sustainability/. Accessed Feb 13, 2008.

Baden S, Barber C (2005) The impact of the second-hand clothing trade on developing countries. Oxfam Int

EDIPTEX (2007) Environmental assessment of textiles. Danish Ministry of the Environment, Environmental Protection Agency

EIPRO (2006) Environmental impact of products. Analysis of the life cycle environmental impacts related to the final consumption of the EU-25. European Commission, Joint Research Centre, Institute for Prospective Technological Studies

ERM (2002a) Streamlined life cycle assessment of textile recycling. Report completed for the Salvation Army Trading Company Ltd by Environmental Resources Management (ERM) Ltd

ERM (2002b) Streamlined life cycle assessment of two Marks & Spencer plc apparel products. Report completed for Marks & Spencer by Environmental Resources Management (ERM) Ltd

Farrant L (2008) Environmental benefits from reusing clothes. Master Thesis at the Technical University of Denmark

Fenger C (2007) Personal communication with Christian Fenger, general manager of The Gaia Movement in Switzerland

Fields S (2004) The beneficial nature of the second-hand clothing trade in Sub-Saharan Africa

Gram-Hanssen K (2008) Understanding everyday routines of energy consumption. Chapter 1: heat comfort and practice theory. Aalborg University. Danish Building Research Institute

Hansen K (2004) Helping or hindering? Controversies around the international second-hand trading trade. Anthropol Today 20 (4):3–9

Hansen J (2008) Personal communication with John Hansen from the Danish Technological Institute

Hauschild M (2007) Lecture slides on human toxicity and ecotoxicity. Master course Life Cycle Assessment of Products and Systems. Technical University of Denmark

Nakano Y (2006) Perception towards clothes with recycled content and environmental awareness: the development of end markets. Centre for Design Research, Northumbria University, UK

Oakdene Hollins Ltd, Salvation Army Trading Company Ltd & Nonwovens Innovation & Research Institute Ltd (2006) Recycling of Low Grade Clothing Waste

Piibeleht P (2008) Personal communication with Pille Piibeleht, manager of Humana's sorting center in Tallinn, Estonia

Reckwitz A (2002) Toward a theory of social practices: a development in culturalist theorizing. Eur J Soc Theory 5(2):245–265

Schatzki TR (2002) The site of the social. A philosophical account of the constitution of social life and change. Pennsylvania State University Press

Wenzel H, Hauschild MZ, Alting L (1997) Environmental assessment of products. Vol. 1: methodology, tools and case studies in product development. Kluwer, Hingham, MA, USA (ISBN 0 412 80800 5)